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# Minimally Invasive Lateral Approach for Anterior Spinal Cord Decompression in Thoracic Myelopathy

*Edna E. Gouveia, Mansour Mathkour, Erin McCormack, Jonathan Riffle, Olawale A. Sulaiman and Daniel J. Denis*

## Abstract

Myelopathy can result from a thoracic disc herniation (TDH) compressing the anterior spinal cord. Disc calcification and difficulty in accessing the anterior spinal cord pose an operative challenge. A mini-open lateral approach to directly decompress the anterior spinal cord can be performed with or without concomitant interbody fusion depending on pre-existing or iatrogenic spinal instability. Experience using stand-alone expandable spacers to achieve interbody fusion in this setting is limited. Technical advantages, risks and limitations of this technique are discussed. We conducted a retrospective chart review of all patients with thoracic and upper lumbar myelopathy treated with a lateral mini-open lateral approach. Review of the literature identified 6 other case series using similar lateral minimally invasive approaches to treat thoracic or upper lumbar disc herniation showing efficient and safe thoracic disc decompression procedure for myelopathy. This technique can be combined with interbody arthrodesis when instability is suspected.

**Keywords:** Expandable, interbody, lateral, minimally invasive, thoracic myelopathy

## 1. Introduction

Rapidly progressing myelopathy can result from a thoracic or upper lumbar disc herniation compressing the anterior spinal cord. With a prevalence of approximately 6.5%, thoracic disc herniation (TDH) is not routinely diagnosed [1]. This low incidence contributes to the lack of familiarity with treatment methods and several factors contribute to a reticence for treating TDH. The calcified or ossified nature of the pathology, the difficulty to safely access and decompress the anterior spinal cord without causing worsening myelopathy and the complications associated with thoracic or thoracolumbar spinal approaches make this condition challenging for the spine surgeon.

The anterior thoracotomy approach has been traditionally considered as a treatment of choice to treat thoracic disc pathology. Compared to the posterior

approaches, such as the costotransversectomy, anterior approaches can offer increased visualization and access to safely decompress midline thoracic lesions. To minimize pain and pulmonary complications associated with thoracotomy, thoracoscopic [2] and more recently the lateral mini-open technique have been reported to treat thoracic disc pathology [3–9]. Although considered a lateral approach, this technique offer direct access to the anterior spinal canal without requiring retraction of the dural sac. Another significant advantage of the lateral



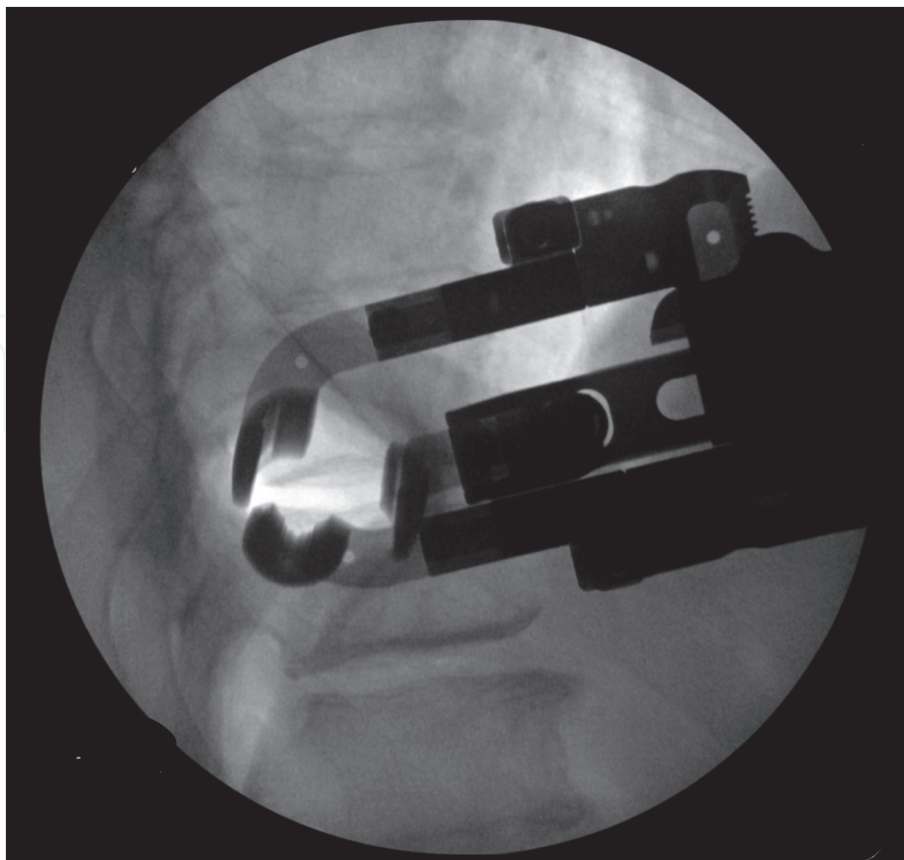
**Figure 1.**  
*The lateral decubitus position was used for the thoracic mini-open lateral approach in a patient with T10–11 myelopathy. Note that the tape used to secure the upper body should be positioned closer to the shoulders in the case of a more rostral thoracic spinal level.*

mini-open approach is it can be performed without depending on a thoracic access surgeon.

## 2. Surgical procedure

Under general anesthesia and without dual-lumen intubation, patients are positioned on lateral decubitus (**Figure 1**). Motor and sensory evoked potentials are monitored intraoperatively. A left or right side approach is chosen to access the same side of the disc protrusion if lateralized. Careful preoperative review of thoracic spine computed tomography (CT) and/or magnetic resonance imaging (MRI) helped localize the large vessels. Pre-operative hook-wire localization can be performed to accurately localize the pathology [4]. For midline anterior lesions, the senior author prefers a right-sided approach to avoid the descending aorta from T5–6 to T8–9. The location of the descending aorta on the left side of the vertebral body from T5 to T8 needs to be taken into account if the contralateral annulus needs to be released during the interbody arthrodesis. Breaking the table is usually not performed.

Under fluoroscopic localization, the anterior and posterior limit of the vertebral bodies above and below the pathological level are delineated. A 3–5 cm incision must span the entire anteroposterior distance of the disc space and is extended posteriorly over or between the underlying ribs. After blunt dissection of the intercostal muscles the rib is partially resected using Leksell and/or Kerrisons rongeurs. The bone is kept as autograft or can be replaced using rib reconstruction techniques to reduce intercostal wound pain. The retropleural space is then dissected bluntly by



**Figure 2.**  
*Intraoperative fluoroscopic image showing positioning of the retractor. The working space is centered over the posterior disc space and the anterior spinal canal junction.*

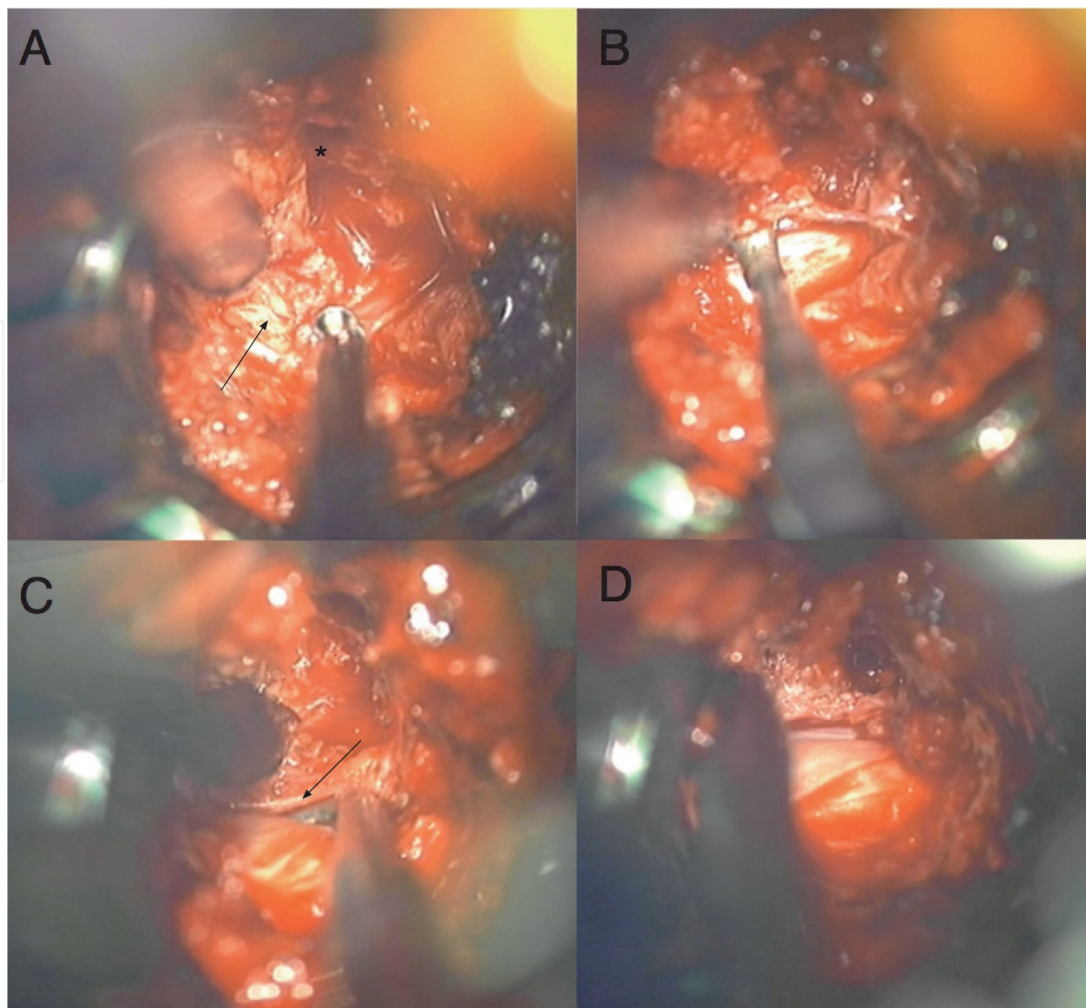


retracting the parietal pleura from the thoracic wall using sponge sticks or endoscopic kittners. Further rib resection posteriorly may help the dissection if needed. The rib head is then palpated in the retropleural space. Serial dilators are inserted and the retractor blade length is chosen. Using fluoroscopy in lateral projection the table-mounted 3 blade retractors are centered at the junction of the posterior disc and the canal (**Figure 2**). The middle blade is oriented anteriorly toward the lung to retract the parietal pleura. This leaves a space between the caudal and cranial blades where instruments can be freely manipulated (**Figure 3**). In the case where the parietal pleura is inadvertently torn and the lung is visualized, the approach becomes transthoracic and a placement of a laparotomy compress between the lung and the middle blade aids with exposure as well as protects the visceral pleura.

Using the operating microscope or loupes with a headlight, the parietal pleura over the rib head and disc space is divided using a long tip cautery tool. Careful attention is aimed at preserving the exiting nerve root. When identified, the exiting nerve root can be retracted and protected with the cranial blade of the retractor.



**Figure 3.**  
*Left-sided approach. The surgeon is facing the back of the patient. The patient head is to the right side of the picture. The orthostatic retractor is positioned with the middle blade retracting the parietal pleural and lung away from the surgeon. Instruments are manipulated between the caudal and rostral blades.*

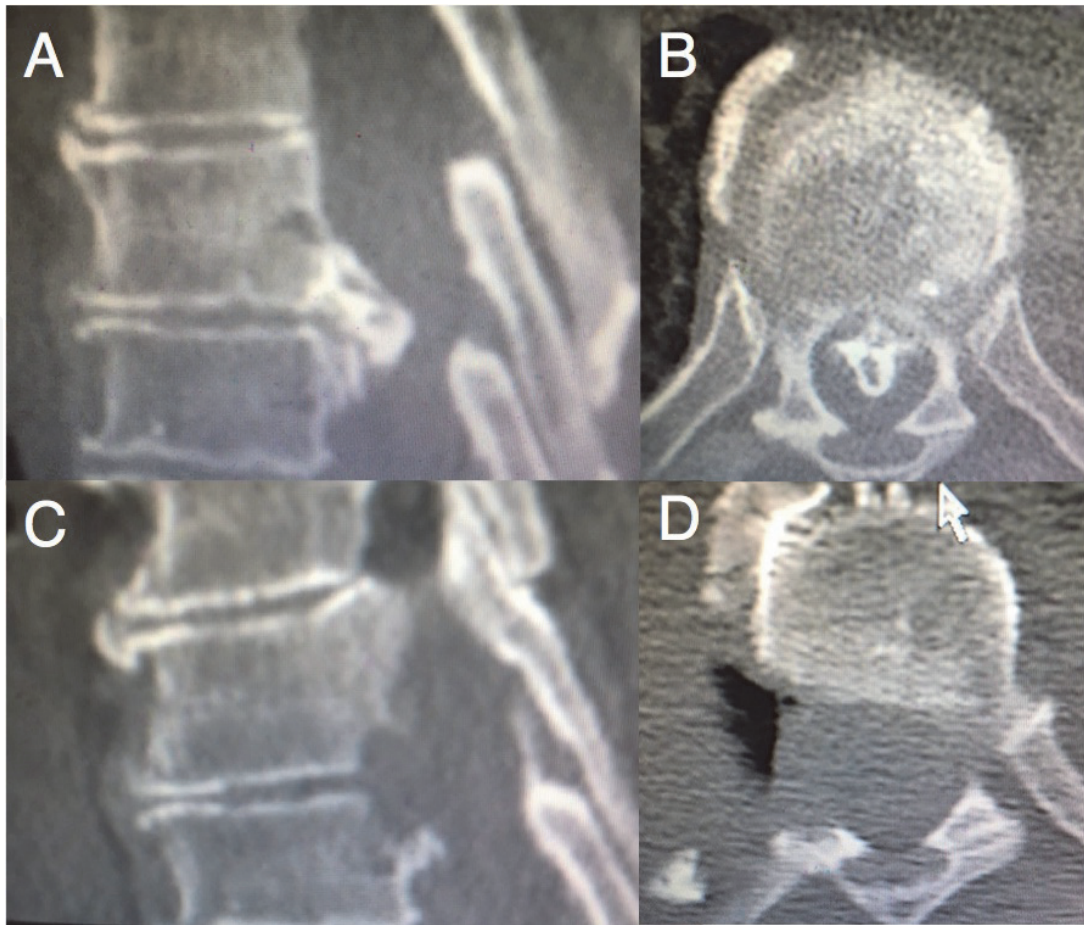


**Figure 4.**

*Intraoperative images under microscopic visualization. A: The rib head has been resected and bony struts (\*) have been drilled to delineate the posterior disc space. A soft disc herniation (arrow) is encountered once the spinal canal is entered. B: The dura become more apparent and discectomy anterior to the dura is carried out. C: A curved curette is placed between the posterior longitudinal ligament (arrow) and the anterior dural sac. D: The anterior dura has been decompressed.*

Using a high-speed drill with 16-cm minimally invasive curve attachments (Stryker, Kalamazoo, MI), the rib head is drilled and bony struts are created in the vertebral bodies on each side of the posterior disc space to create a partial corpectomy space where disc fragments can be dislodged without retracting the dural sac. Drilling of the superior pedicle of the inferior vertebral body helps to expose the spinal canal. The posterior disc is removed with pituitary rongeurs. Ossified disc herniations are drilled laterally just anterior to the dural sac until they become completely freed from the vertebral bodies and disc space. Then the remaining osteophytes can be gently dissected from the posterior longitudinal ligament (PLL) and dura in the partial corpectomy space without excessive manipulation of the spinal cord (**Figure 4**). Resection of the PLL helps to visualize the dura to assess the decompression. Once the dural sac is fully decompressed anteriorly, an interbody arthrodesis can be accomplished by mobilizing the retractor in the center of the disc space in the anteroposterior plane. The discectomy can then be completed with serial shavers. The contralateral annulus can be released with a Cobb elevator in order to place an interbody cage which spans the full apophyseal ring of the vertebral bodies. An expandable stand-alone cage (Rise-L, Globus Medical, Audubon, PA, USA) filled with autograft and allograft is then positioned. A Jackson-Pratt or Hemovac drain is left in the retropleural or intrapleural cavity. In the event of a visceral pleura laceration, placement of a chest tube is preferred (**Figures 5–7**).



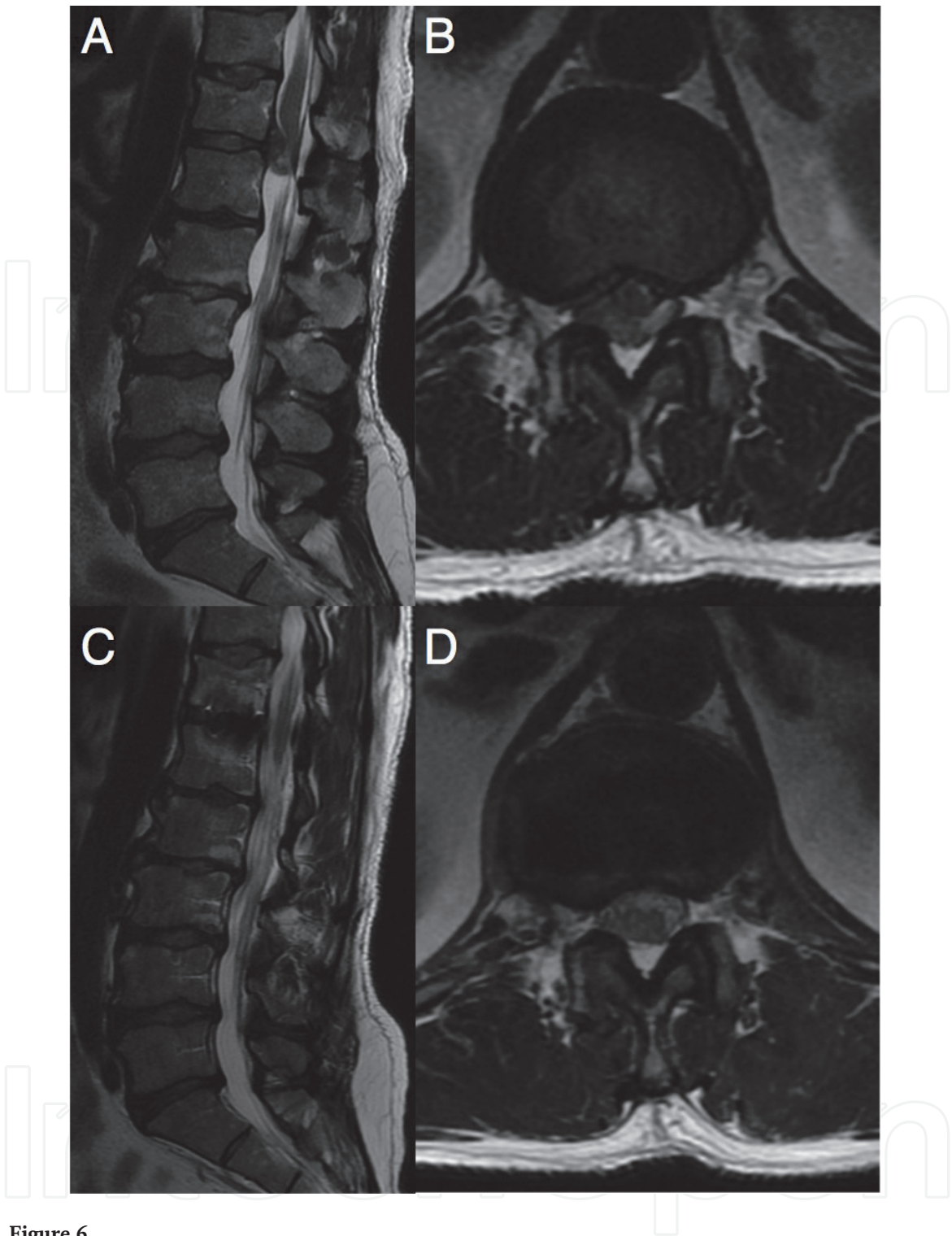


**Figure 5.** Preoperative sagittal (A) and axial (B) computed tomography images show an ossified disc herniation at T7–8 in a 72 years old female. Post-operative images (C–D) show complete decompression of the spinal canal.

### 3. Experience and review of literature

This technique has been preferred by the author to treat one or two levels thoracic myelopathy. A total of 15 consecutive cases, 73% males and 27% females, who underwent a thoracic or thoracolumbar lateral mini-open approach to decompress the anterior spinal canal were included (**Table 1**). Mean age at surgery was 55.8 years (range, 38–76) and mean body mass index was 33.8 kg/m<sup>2</sup> (range, 22.8–50.9). Fourteen patients presented with myelopathy symptoms while only six patients presented with radicular thoracic pain. A calcified disc was found in two patients. The most frequent level affected was T10–11. Two patients had two consecutive levels treated. Mean estimated blood loss was 400 mL (range, 50–2150) and mean operative time was 188 minutes (range, 113–328). Mean length of stay was 8 days (range, 2–23). No positive correlation was found between BMI and ORT,  $r = 0.2392$ ,  $p = 0.2073$ . Elective surgery was performed in 8 cases with a mean length of stay of 4 days (range, 2–9). At a mean follow-up of 11.1 months, myelopathy significantly improved in a majority of patients (**Tables 1 and 2**).

The mini-open direct lateral approach has gained popularity to perform indirect decompression and interbody fusion in the lumbar spine [10] (**Tables 3 and 4**). Below the L2–3 level, the direct lateral approach is usually not performed to directly decompress the spinal canal because placement of the retractor more dorsally can result in direct nerve injury due to the proximity of the lumbar plexus [9]. Above L1–2, the mini-open lateral approach can be safely performed to remove midline anterior lesions and directly decompress the spinal cord and ipsilateral exiting nerve



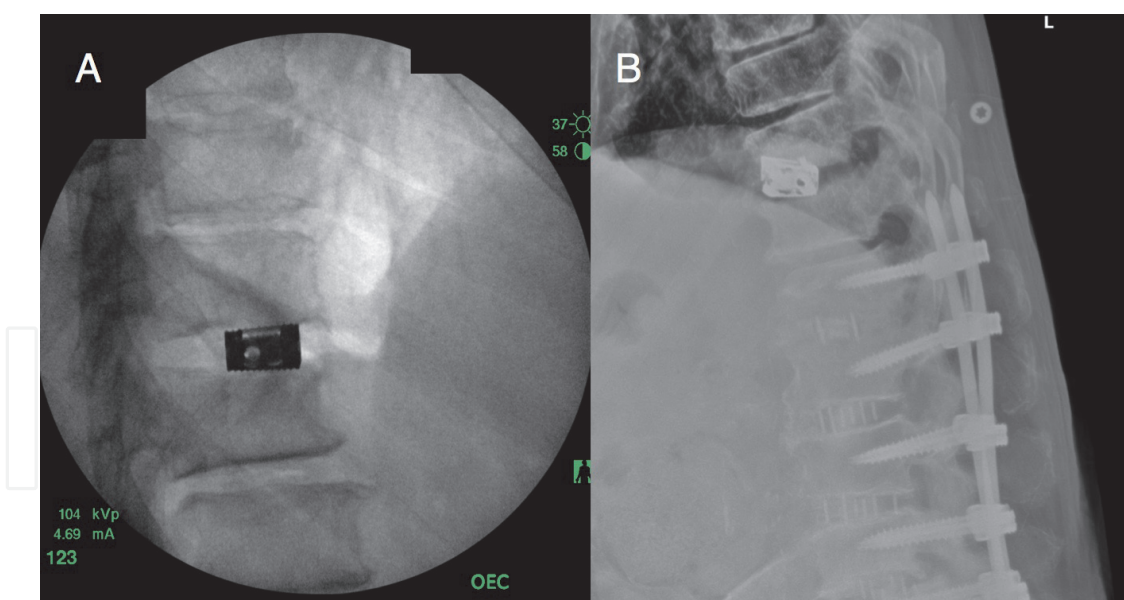
**Figure 6.**  
*Preoperative sagittal (A) and axial (B) T2-weighted magnetic resonance images of a soft disc herniation at T12–L1 in a 51 years old male. Post-operative images (C–D) show decompression of the spinal canal. Note that expandable cage artifacts do not affect interpretation.*

root (**Table 5**). At L1–2 and L2–3, the author experience has shown this approach to be useful in decompressing the anterior spinal canal but special care needs to be taken to identify and protect the exiting nerve root.

### 3.1 Obesity and surgical outcomes

Obesity is a risk factor for lumbar spondylosis [11, 12] and prior studies suggest that class I obesity is frequently found in patients with symptomatic thoracic or thoracolumbar spondylosis [7, 9]. The mini-open lateral approach was found to be





**Figure 7.**

**A:** Intra-operative fluoroscopy showing ideal placement of expandable interbody spacer (case no. 7). **B:** Example of cage subsidence 6 weeks after surgery in case no. 13.

ideal in treating morbid obese patients as the amount of adipose tissue did not interfere with the approach (**Figure 8**). The working length is increased in obese patients, mandating usage of longer retractor blades, but the body mass index is not associated with increased surgical time.

### 3.2 Concomitant interbody arthrodesis and supplemental instrumentation

Delayed deformity following thoracic discectomy without instrumented fusion has been reported as low as <3% [13]. In the case of rapidly worsening myelopathy caused by extrusion of a soft or partially calcified thoracic disc, concomitant arthrodesis is often performed as the condition is thought to result from chronic instability [13, 14]. The extent of the decompression by removing the posterior longitudinal ligament (PLL), the ipsilateral inferior pedicle and/or the lateral facet complex can also potentially increase segmental instability. However the natural history and pathophysiology of TDH presenting with myelopathy is still poorly understood and large thoracoscopic series has been performed without arthrodesis with successful long-term outcomes [15, 16].

Expandable lateral interbody cages have been shown to provide immediate stability, limiting flexion, extension, lateral bending and axial rotation comparable to static cages [17]. The main advantage is considered to be the small cage height (7 mm) at implantation, which is thought to minimize vertebral endplate disruption thus potentially decreasing later implant subsidence. The use of BMP-2 for interbody arthrodesis or adding supplemental anterior or posterior instrumentation should be considered when pre-existing factors that can lead to pseudoarthrosis are present.

The author prefers using expendable spacer to decrease the risk of device migration during insertion. Because the PLL is frequently divided during the decompression procedure, a larger static cage could accidentally slip posteriorly during placement in the kyphotic thoracic spine, resulting in cord compression. This risk is similar to anterior cage migration during implantation of static cages when anterior longitudinal ligament release is performed for deformity correction in the lumbar spine [18].

Case no.	Age	Sex	Smoker	BMI	Myel.	Rad.	Cal.	Level (s)	Trans.	Arthro.	EBL (ml)	ORT (min)	LOS (days)
1	72	Female	No	31.7	Yes	No	Yes	T7–8	No	No	2150	233	3
2	51	Male	No	29.0	Yes	Yes	No	T12–L1	No	Yes	200	263	4
3	43	Male	No	50.9	Yes	No	No	T10–11	No	Yes	750	328	11
4	53	Male	No	40.0	Yes	No	No	T11–12	No	Yes	350	134	12
5	71	Male	No	29.0	Yes	No	No	T10–11	Yes	Yes	100	182	9
6	39	Male	Yes	24.0	Yes	Yes	No	T9–10	Yes	Yes	250	163	2
7	57	Male	No	31.1	Yes	No	No	T11–12	No	Yes	75	195	2
8	50	Female	No	35.8	Yes	No	Yes	T9–10	No	Yes	50	156	3
9	41	Male	No	43.0	Yes	Yes	No	T10–11	No	Yes	250	165	13
10	66	Male	No	40.7	Yes	No	No	T10–11, T11–12	No	Yes	1000	214	14
11	59	Male	No	32.9	Yes	Yes	No	T10–11	No	Yes	75	113	3
12	51	Female	No	29.5	No	Yes	No	T10–11	No	Yes	200	146	4
13	70	Male	Yes	22.8	Yes	No	No	T11–12	No	Yes	100	129	23
14	38	Male	No	32.9	Yes	No	No	T5–6	No	Yes	300	192	15
15	76	Female	No	33.6	Yes	Yes	No	T11–12, T12–L1	No	Yes	150	226	7

Abbreviations: Arthro., interbody arthrodesis; BMI, body mass index; Cal., calcified disc; EBL, estimated blood loss; LOS, total length of stay; Myel., myelopathy; ORT, operative time; Rad., radicular pain; Trans., transpleural.

**Table 1.**  
Cases demographic, clinical and surgical data.

Case no.	Preoperative	Postoperative
1	3	3
2	2	3
3	3	7
4	3	3
5	3	4
6	3	3
7	4	5
8	6	7
9	2	3
10	3	6
11	5	7
12	N/A	N/A
13	2	3
14	2	3
15	2	2

N/A, not applicable because the patient had radiculopathy without myelopathy.

**Table 2.**  
Motor dysfunction score of the lower extremities by the modified Japanese Orthopedic association scale.

	No.	Sex (% female)	Age	BMI	Myel. (%)	Rad. (%)	Cal. (%)	EBL (ml)	ORT (min)	LOS (days)	Trans. (%)	Chest tube (%)	Myel. stable or improved (%)
Present study	15	27	55.8	33.8	93.3	40	13.3	400	188	8	13	0	100
Bartels et al. [3]	21	57	58.8	N/A	100	4.7	100	732	222	N/A	100	100	100
Deviren et al. [4]	12	67	53	N/A	66.7	0	N/A	440	210	5	100	100	100
Kasliwal and Deutsch [5]	7	42.9	52	N/A	100	57.1	N/A	180	N/A	2.6	0	0	42.8
Malham et al. [6]	3	33	61.7	28.6	33.3	33.3	0	<50	N/A	5	66	33	100
Nacar et al. [7]	33	54	52.9	31	69.7	93.9	57.5	300	174	5	76	76	91
Uribe et al. [9]	60	47	57.9	31	70	51.6	33	290	182	5	75	22	83.3

Age, BMI, EBL, ORT, LOS values are means. Abbreviations: BMI, body mass index; Cal., calcified disc; EBL, estimated blood loss; LOS, length of stay; Myel., myelopathy; No., number of cases; N/A, not available; ORT, operative time; Rad., radicular pain; Trans., transpleural.

**Table 3.**  
Literature review on mini-open lateral approach for symptomatic thoracic or upper lumbar disc disease: Demographic, clinical and surgical data.

3.3 Operative complication

The most frequent reported complication in the literature was intra-operative cerebrospinal fluid leak (**Table 6**). This complication was associated with calcified



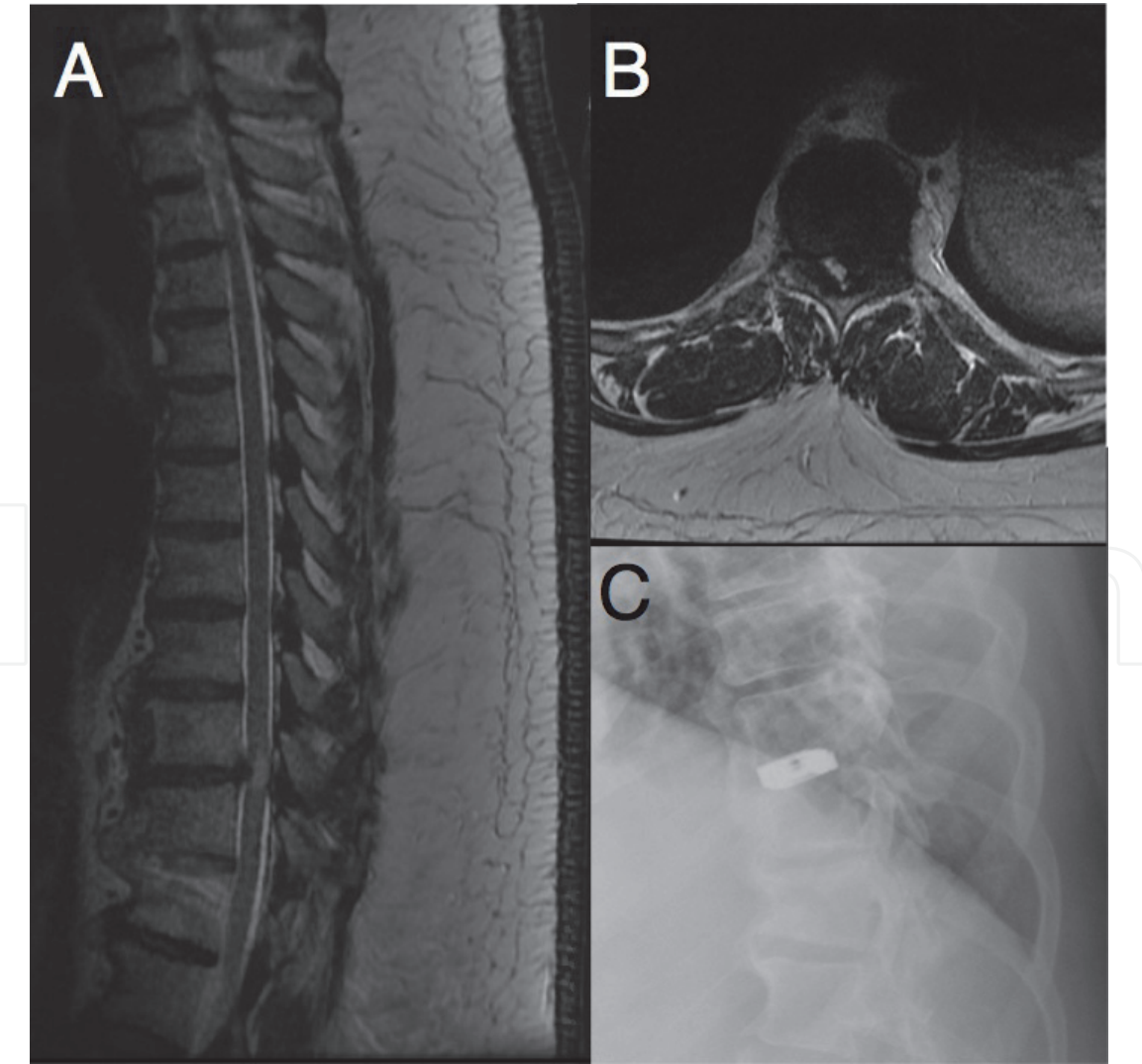
	Static cage (%)	Expandable cage (%)	Autograft only (%)	Allograft only (%)	Autograft and allograft (%)	rhBMP-2 (%)	Sup. anterior inst. (%)	Sup. posterior decom. and inst. (%)	Sup. posterior decom. Only (%)
Present study	0	93	13	0	80	0	7	0	0
Bartels et al. [3]	0	0	0	0	0	0	14	0	0
Deviren et al. [4]	100	0	100	0	0	3	100	8	8
Kasliwal and Deutsch [5]	0	0	0	0	0	0	0	0	0
Malham et al. [6]	100	0	0	100	0	100	0	0	0
Nacar et al. [7]	100	0	N/A	N/A	N/A	N/A	100	3	9
Uribe et al. [9]	90	0	57	0	40	3	33	10	3

Abbreviations: Decom. = Decompression, Inst. = Instrumentation, N/A = not available, Sup. = Supplemental

**Table 4.**  
*Literature review on mini-open lateral approach for symptomatic thoracic or upper lumbar disc disease: Interbody arthrodesis and supplemental surgical data.*

Level	Present study	Bartels et al. [3]	Deviren et al. [4]	Kasliwal and Deutsch [5]	Malham et al. [6]	Nacar et al. [7]	Uribe et al. [9]
T4-5	0	0	0	0	0	0	2
T5-6	1	1	0	0	0	2	1
T6-7	0	3	1	1	1	3	8
T7-8	1	2	1	2	0	8	12
T8-9	0	1	1	2	0	3	12
T9-10	2	3	0	2	1	2	8
T10-11	6	4	1	1	0	5	9
T11-12	4	8	4	0	0	8	14
T12-L1	2	0	4	0	1	6	7
L1-2	0	0	0	0	0	0	1
L2-3	0	0	0	0	0	0	1

**Table 5.**  
*Literature review on mini-open lateral approach for symptomatic thoracic or upper lumbar disc disease: Spinal levels treated.*



**Figure 8.**  
*Preoperative sagittal (A) and axial (B) T2-weighted magnetic resonance images of a soft disc herniation at T10-11 in a 42 years old male with body mass index of 43.0. C: Postoperative sagittal x-rays showing decompression and placement of an expandable interbody cage in the same patient.*

	Present study	Bartels et al. [3]	Deviren et al. [4]	Kasliwal and Deutsch [5]	Malham et al. [6]	Nacar et al. [7]	Uribe et al. [9]
Intra-operative CSF leak	1	2	0	0	0	2	7
New lower extremity weakness	0	1	0	0	0	0	1
Neuropathic pain at incision	2	0	1	0	1	1	1
Pleural effusion	6	N/A	1	0	N/A	2	1
Pneumothorax	0	0	0	0	0	0	1
Post-op chest tube	2	N/A	1	0	N/A	2	1
Reoperation	1	0	0	0	0	0	3
Cage subsidence	2	N/A	N/A	N/A	N/A	N/A	N/A
Pseudoarthrosis	1	N/A	N/A	N/A	N/A	0	0

Abbreviation: CSF, cerebrospinal fluid; N/A, not available.

**Table 6.**  
*Literature review on mini-open lateral approach for symptomatic thoracic or upper lumbar disc disease: Complications.*

disc herniations and could be successfully repaired [7, 9]. Case no. 1 who had a calcified thoracic disc herniation had a small intraoperative cerebrospinal fluid leak repaired with onlay allograft and DuraSeal® (Covidien, Waltham, MA, USA). Other postoperative complications included 6 pleural effusions, two of which required interventional radiology placement of chest tube. Costovertebral neuralgia is usually treated with neuropathic pain medication such as gabapentin or pregabalin. Topical lidocaine can also be used.

3.4 Limitations

The results of this study need to be interpreted with caution because of its retrospective nature and the limited number of cases reported. Although the outcomes were consistent with the literature, long-term follow-up would be necessary to better assess the risk of pseudoarthrosis and the persistence of resolution of symptoms.

4. Conclusion

A larger number of case series have reported successful treatment of symptomatic TDH using the mini-open lateral technique. With a short length of stay for elective cases, a relatively low complication rate and improvement of motor function in the majority of patients, the mini-open lateral approach can be considered a safe and effective procedure for symptomatic TDH. Arthrodesis using expandable cages without additional anterior instrumentation can provide satisfactory short-term outcomes. However supplemental anterior or posterior fixation should also be considered when significant pre-existing instability is suspected, when multiple contiguous levels are treated or when significant cage subsidence is noted during cage expansion.



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